A REVIEW ON INDIVIDUAL SPACE-TIME BEHAVIOR, ACTIVITY PATTERNS AND HEALTH IMPACT ASSESSMENT

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ABSTRACT

Many studies have examined the relationship between the built environment and health. Yet, the question of how and why the environment influences health behavior remains largely unexplored. As health promotion interventions work through the individuals in a targeted population, an explicit understanding of individual behavior is required to formulate and evaluate intervention strategies. Bringing in concepts from various fields, this paper proposes the use of an activity-based modeling approach for understanding and predicting, from the bottom up, how individuals interact with their environment and each other in space and time, and how their behaviors aggregate to population-level health outcomes.

Keywords: *Built environment; overweight and obesity; individual-based modeling; space time behavior; activity patterns; health impact assessment*

1. INTRODUCTION

Human behavior depends on the environment in which it takes place, while in turn people also influence the environment by their presence and activities. As part of the environment, people behave in response to both physical and social settings. In fact, every individual not only adapts to his or her physical and social environment but also makes up part of the social environment of other individuals. Obviously, there are more forces affecting both individuals and the environment. For instance, businesses and organizations located in the environment will influence where people travel, while governments and institutions exercise rules and mechanisms that affect the behavior of individuals, households, businesses and organizations. An understanding of this multi-layered network of interactions is required when environmental design is intended as an instrument to establish desired behavior, e.g., to encourage walking and cycling, or to create safer places. Over the last two decades, the field of health promotion has demonstrated increased attention for the possible impact of the environment on health. It has been recognized that the channels of impact are multi-faceted and exist at multiple levels of hierarchy. A social-ecological perspective has become the common approach to categorize the various environmental influences on individual health behavior. Besides the roles of individual and interpersonal characteristics, a social-ecological approach distinguishes the impacts of organizational and institutional circumstances, as well as aspects related to the community and society.

2. INFLUENCES OF ENVIRONMENT ON OVERWEIGHT

In the last decade, rapidly increasing rates of overweight and obesity have become a major public health concern around the world. For instance, in Europe, the prevalence of overweight (i.e., a body mass index between 25 and 29.9 kg/m2) now ranges between 32-79% in men and 28-78% in women, while the prevalence of obesity (i.e., a body mass index of 30 kg/m2 or more) ranges between 5-23% in men and 7-36% in women. A strong evidence base exist about the various health consequences of overweight and obesity, such as cardiovascular problems, type 2 diabetes, certain cancers and psychosocial problems. Many epidemiological studies have been dedicated to identifying those segments of the population in which overweight or obesity is most prevalent. Generally, it is found that those who are female, middle- aged, ethnic minority, unemployed or in unskilled jobs, lower income,

less educated, living with others, married, parents, rural, and/or living in particular regions are more likely to be obese. This wide range of factors reveals some of the complexity underlying the overweight and obesity issue. In search for the causes, it is widely agreed upon that the increasing rates have occurred too rapidly to be primarily due to genetic factors and, thus, that changes in non- genetic factors must be playing a major role.

3. COMPLEXITIES

Understanding the causal pathways and mechanisms between an intervention and behavioral outcomes is important if the full ramifications of policies are to be understood. However, many questions still remain to be answered. Especially, the conceptualization of the built environment is not agreed upon, and the heterogeneity of human behavior is not well understood. Studies investigating the relationship between the built environment and health behaviors have usually investigated the effects of only a limited number of built environment characteristics, and mainly with a restricted focus on suburban areas. They have used only crude proxies for the relevant geographic areas and for the attributes that may be important. It is not clear how individuals perceive the neighborhood space and scale, and how they filter spatial information when making their behavioral choices.

4. METHODOLOGICAL SHIFT

Several academics have suggested the use of system thinking, mainly based on the concepts of the social-ecological framework, to ensure a comprehensive look at the factors influencing health behaviors at different hierarchical levels. However, the field has not reached further than a few attempts to map or conceptualize the interrelationships and relative importance of various factors. The system of mechanisms underlying health behaviors in their social- ecological settings refers to human group processes that are highly complex, nonlinear, path dependent, self-organizing and dynamic. To understand the operation of such systems, a modeling approach is needed that is different from the common statistical models that try to capture system regularities under restrictive or unrealistic assumptions including linearity, homogeneity, normality, and stationary. In reality, individuals are the actual building blocks of the system under study. The aggregate properties of interest in a population or community (e.g., the prevalence of overweight and obesity) emerge from the behaviors of individuals in response to their environment and each other. Instead of trying to model this at the system-level, it appears more natural and fruitful to apply a bottom-up approach called individual-based modeling. Next, regression-based techniques are applied to identify associations between the environmental measures and these health- related measures (Figure 1). This approach sidesteps how health behaviors actually occur as a result of individuals interacting with their environment and with each other. To model and predict environmental impacts on health behaviors such as physical activity and nutrition, it will be necessary to understand how different activities are linked in space and time at the individual level. More specifically, it needs to be understood which health-related activities people are conducting where, when, for how long, with whom and so on.

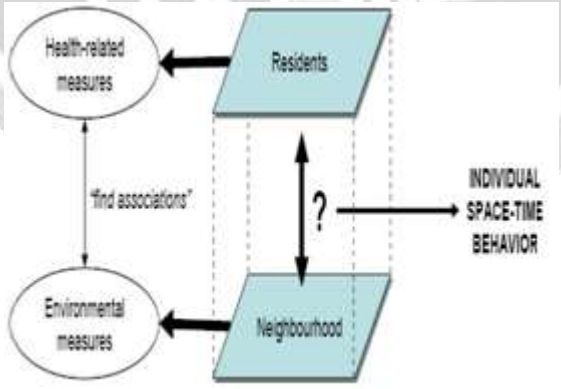

Fig-1 The contemporary approach to study environmental impacts on health behaviors (left), and the missing link of individual space-time behavior (right).

5. SPACE-TIME BEHAVIOR

Spatial behavior in response to the built environment is a topic that can be assigned to the field of behavioral

geography. Since the 1970s, this field has produced theories and models of preference and choice that are widely used to predict the likely impacts of policy decisions on spatial behavior and to assess the feasibility of envisaged projects. The available choice sets will differ between persons, they will evaluate the alternatives based on different sets of attributes, and they will make different trade-offs when deciding. Furthermore, all these aspects can vary over space and time. Since the 1990s, the field of land use and transportation planning has seen a rapid increase in so- called activity-based modeling, which conceptualizes activity patterns of individuals as sequences of activities over space and time, governed by opportunities and a variety of constraints. Some research has been emphasizing particular facets of space-time behavior (e.g., activity duration, time allocation, trip- chaining and stop-pattern formation), but there is an increasing number of studies suggesting more comprehensive models of activity-travel patterns. For instance, models now often contain elements of institutional context and also address intra- household decision making. Determining the choice set available to an individual requires careful consideration. As mentioned earlier, it is reasonable to say that behavior in the local neighborhood will be influenced by the wider environment. This approach is believed to provide us key concepts of individual space-time behavior needed for thinking about and investigating environmental impacts on health behaviors.\

6. ACTIVITY-BASED MODELING

Activity-based models simulate which activities people are conducting, where, when, for how long, with whom, the transport mode used and possibly some other characteristics. The level of representation of time and space tends to be high, implying that very detailed simulations and predictions are possible. The activity-based approach goes back to various disciplines. It was originally suggested in urban planning and geography but especially in mid 1990 it received a highly significant impulse in transportation research, with several hundred of publications annually. Most of this output concerns the results of empirical analyses of particular aspects of activity-travel patterns, but in addition several operational models have become available in recent years. New technologies have led to or promise new advances in data collection, giving new opportunities for the further development of activity-based models. In the mid 1990s, transportation researchers advocated to replace so-called four-step models by activity-based models. The four-step approach simulated travel by predicting, at an aggregate level, trip generation, destination choice, mode choice and route choice as independent processes. Activity based models have been advocated for a variety of reasons. First, empirical evidence suggests that an increasingly larger percentage of trips are not home-based as a result of changing distributions of land use, time pressure and higher car availability rates. Because traditional transport demand models are based on home-based trips, they introduce systematic error and the amount of error has significantly increased. Secondly, the policy agenda has changed. Whereas traditionally transport demand forecasting models were developed to assess the feasibility and impact of major new infrastructure, since the 1990s this policy orientation has been supplemented with a focus on transport demand management. In addition, environment-related concerns have been added to the policy agenda. These changing policies have triggered a need for a more detailed modeling system, increasing resolution in both time and space. Thirdly, empirical research has shown that response patterns to transport demand management can be quite diverse. It led to the need of modeling interdependencies between choice facets of transport demand as opposed to the assumed independence of trip-based models. Another reason for developing activity-based models is to improve the consistency of travel forecasting by developing a more integrated approach. To support decision-making about health promotion interventions, studies will need to aim at understanding and predicting how such interventions will change individual health behaviors in space and time, and how this aggregates to population-level health outcomes (Figure 2).

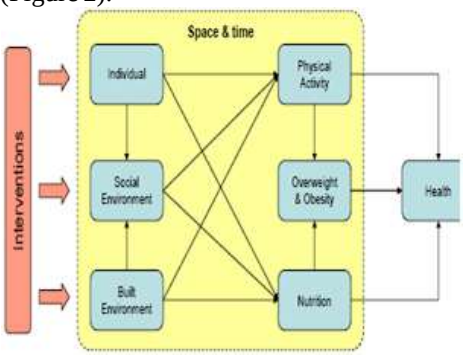

Fig-2 Space-time behavior as the underlying concept for studying the health impacts of environmental interventions (here related to overweight and obesity).

Although space-time behavior is a largely unexplored area for researchers in health promotion and public health, it is the central focus in land use and transportation planning. This field has seen an evolution from aggregate models to disaggregate models. Now, activity-based modeling is the state of the art approach to model and predict individual space-time behavior. Albeit that this approach is mostly finding application at the level of cities or regions, its general concepts can easily be applied to smaller areas. This is especially so, now that the adoption of new data collection techniques such as GPS instruments is giving access to data at the fine-grained scale needed for studies at the local neighborhood level. Adoption of this methodology could materialize the highly needed move from the general thesis that neighborhoods affect health to the specifics of how and why this may occur. Oriented at individual behavior, it offers an integrated perspective in which the focus is not on statistical relationships between characteristics of the built environment and particular health issues, but on how the built environment affects, among other factors, the way people organize their activities and travel in space and time and how this in turn affects their health. Further development will involve enhancing or adding behavioral rules to capture a certain desired effect. When the representation of behavior has reached a satisfactory level, the approach will provide great flexibility to test models in different or increasingly complex environments. This would only require bringing the model's population in line with the population of the environment to be investigated.

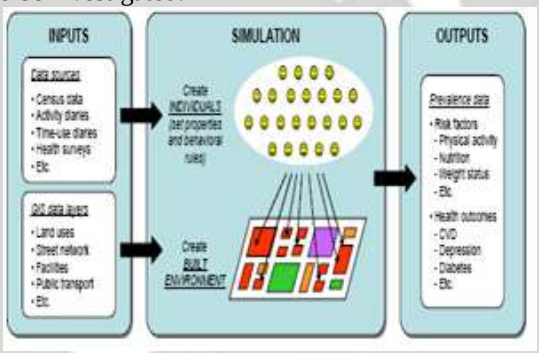

Fig-3 Schematic overview of an activity based model of health behavior.

Individual-based models can operate as virtual laboratories to run controlled experiments of hypothetical interventions. Through simulation, they allow a comprehensive and structured assessment of impacts of different interventions on health behaviors in a population under study. This gives them potential as an instrument for prospective quantitative Health Impact Assessment (HIA). HIA addresses the possible effects of a policy, program or project on the health of a population and the distribution of those effects within the population. Individual based models will be naturally suitable to account for individual differences in exposure and susceptibility to environmental conditions dependent on personal, geographical or temporal characteristics. This will enable obtaining refined estimates of health impacts and to see how various groups in the population respond to an intervention. Given a user interface that allows one to understand the model, interact with it and interpret its outcomes, an activity-based model of health behavior can serve different purposes and have value to different parties involved in health promotion, public health and urban planning. First, by enabling experimentation with interventions it can be an instrument for researchers to develop models of increasing sophistication and to investigate possible synergies between interventions. As such, it can also serve a role in education. Second, an activity-based model of health behavior can operate as a tool to facilitate communication between academics and policy-makers, practitioners or planners. By simulating how interventions operate through mechanisms of individual behavior to eventually result in outcomes for a population, models can be designed to visualize how outcomes come about. Such insight can give directions in decision-making and play a role in advocating the most suitable and effective interventions for a given case. Finally, visualization can also play a facilitating role in public participation to reach consensus about interventions when changes to the built environment are suggested to community members.

7. REFERENCES

[1]. Bell, P.A.; Fisher, J.D.; Baum, A.; Greene, T.C. Environmental psychology; 2nd ed.; Holt, Rinehart and Winston, Inc.: Fort Worth, TX, USA, 1990.

[2].Lindheim, R.; Syme, S.L. Environments, People, and Health. Annu. Rev. Public Health 1983, 4, 335-359.

[3]. Moudon, A.V.; Lee, C. Walking and biking: An evaluation of environmental audit instruments. Am. J. Health Promot. 2003, 18, 21-37.

[4]. Grimm, V.; Railsback, S.F. Individual- based modeling and ecology; Princeton University Press: Princeton, NJ, USA, 2005.Stokols, D. Establishing and maintaining healthy environments: toward a social ecology of health promotion. Am. Psychol. 1992, 47, 6-22.

[5]. Sallis, J.F.; Cervero, R.B.; Ascher, W.; Henderson, K.A.; Kraft, M.K.; Kerr, J. An ecological approach to creating active living communities. Annu. Rev. Public Health 2006, 27, 297-322.

[6]. Diez Roux, A.V. Integrating social and biologic factors in health research: A systems view. Ann.Epidemiol. 2007, 17, 569-574.

[7].Duhl, L.J.; Sanchez, A.K. Healthy cities and the city planning process: a background document on links between health and urban planning; World Health Organization: Copenhagen, Denmark, 1999.

[8]. TRB. Does the built environment influence physical activity? Examining the evidence; Transportation Research Board: Washington, DC, USA, 2005.

[9]. Giles-Corti, B.; Donovan, R.J. The relative influence of individual, social and physical environment determinants of physical activity. Soc. Sci. Med. 2002, 54, 1793- 1812.

[10]. Li, F.; Fisher, K.J.; Brownson, R.C.; Bosworth, M. Multilevel modelling of built environment characteristics related to neighbourhood walking activity in older adults.[see comment]. J. Epidemiol. Community Health 2005, 59, 558-564.

[11]. Sallis, J.F.; Bauman, A.; Pratt, M. Environmental and policy interventions to promote physical activity. Am. J. Prev. Med. 1998, 15, 379-397.